THE RÔLE OF TEMPERATURE IN HYDRANTH FORMATION IN TUBULARIA

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Tubularia crocea (Agassiz) is a hydroid found on wharfs and piles in the Woods Hole region. It is abundant until the last part of July when the hydranths are dropped and the coenosarc retreats into the perisarc. The colonies remain in this condition until October when growth begins anew. The experiments reported in this paper show that temperature is an important factor in regulating this periodicity.

Autotomy and resorption of hydranths under a variety of conditions have been studied by a number of investigators, for example, Bäschlin (1932), Cerfontaine (1903), Gast and Godlewski (1903), Godlewski (1904), Huxley and deBeer (1923), Loeb (1900), Morse (1909), Riddle (1911), and Thatcher (1903). Morse (1909) made a special study of the cause of autotomy of the hydranth in *Tubularia* and concluded that ". . . temperature seems to be the only consistent factor involved in the decapitation. When the temperature is kept at about 10° C. or 15° C., the hydranths are retained, regardless of any other factors with the one exception of lack of oxygen, which we believe to be inoperative except under wholly artificial conditions." Sumner, Osburn and Cole (1913) recorded the disappearance of *Tubularia crocea* during the summer from the harbor at Woods Hole but noticed that in cooler waters the colonies may remain in an active condition throughout this period. Elmhirst (1922) kept colonies of *Tubularia* in his aquarium for three years and noticed that hydranths appeared in midwinter and were lost in midsummer. Light and oxygen were thought to be the principal factors involved.

If high environmental temperatures cause *Tubularia* to exist in a dormant condition, then keeping them in colder water should result in renewed growth. It was also thought that oxygen might be a factor since its importance in regeneration has been demonstrated by Barth (1937, 1938) and Miller (1937). The following experiments were performed to test the action of temperature and oxygen on dormant colonies of *Tubularia*.

Experiments

On August 6, 1938 an experiment was begun to test the effect of oxygen and temperature on dormant colonies. Two 500 cc. flasks were placed in an 18.4° constant temperature bath. Into one of these, *A*, air was bubbled continuously at the rate of 1 liter per minute. The other, *B*, received oxygen at the rate of 1 liter per 11–14 minutes. These gases kept the water saturated and in rapid motion. Two similar flasks were placed in running salt water which varied from 23.2° to 24° for the duration of the experiment. (Sea water in laboratory tanks is from 0° to 1° warmer than where *Tubularia* grows.) One of these, *C*, received air at the same rate as *A*. The other, *D*, received oxygen at the same rate as *B*. Dormant colonies were placed in these containers. After 72 hours there were many hydranths in *B*, less in *A*, and none in *C* and *D*. At 96 hours nearly every free end of the *B* colony had a fully formed hydranth. In *A* they were not so numerous. *D* showed but two small hydranths (occasionally a hydranth is noticed on dormant colonies as they are collected), and *C* showed none.

On August 18, 1938, colonies were collected and placed in flasks as in the previous experiment. The temperature of laboratory ocean water had fallen to 22° C. The experiment was terminated August 24,

Table I

See text for explanation.

Flask	Temp.	O_2	Total hydranths	Hydranths/gm. colony
	°C.	cc./l.		
A	18.4	5.5	243	128
B	18.4	23.5	116	83
C	22.	5.0	0	0
D	22.	21.3	31	38

the colonies removed from the flasks and the number of hydranths carefully counted under the binocular microscope. The oxygen tension in each flask was determined by the Winkler Method. Excess water was removed from the colonies and their weight determined. The results are shown in Table I.

Discussion

Morse (1909) found that *Tubularia* disappeared when the temperature of ocean water rose to 20° C. We observed that in the summer of 1938 it disappeared when the water temperature was 21°. From Morse's experiments and those here reported it seems highly probable

that autotomy of hydranths and the existence of the colonies in a dormant condition is due to high temperature. Conversely, hydranths will be produced in abundance at a few degrees below 20°. North of Cape Cod where the water does not rise above the critical temperature for *Tubularia,* colonies flourish throughout the summer months (Morse, 1909).

This existence of coelenterates in a state of dormancy in regions where conditions during part of the year do not permit active growth has been pointed out by Broch (1925), who called attention to its similarity to spores in plants.

It is doubtful if oxygen in the concentrations normally present in the sea plays a significant rôle in the disappearance or reappearance of active colonies of *Tubularia.* However, in flask D (Table I), kept at 22°, a number of hydranths were formed. The oxygen tension was far above that ever present in the ocean. On bright days the oxygen tension of water bathing the dormant colonies has measured 6.1 cc. per liter, higher than in either flasks *A* or *C* (Table I) yet there is no renewed growth as long as the temperature is over 20° C. In the experiment conducted at 24° saturation with oxygen failed to produce a significant number of hydranths. It appears that at temperatures just above the critical point a high oxygen tension may stimulate some hydranth formation but this effect is not noticed at still higher temperatures.

The author wishes to thank the Department of Zoölogy of Columbia University for providing facilities for investigating this problem at Woods Hole and Professor L. G. Barth for his helpful suggestions.

Summary

When ocean water rises above 20–21° C. in the Woods Hole region the hydranths of *Tubularia crocea* are lost and the coenosarc retreats into the perisarc. The colonies remain in this dormant condition until the temperature drops in autumn. Growth is then resumed.

The dormant colonies can be stimulated to produce hydranths in three days by keeping them at 18.4° C.

It is thought that temperature is the principal agent in the disappearance and reappearance of active colonies.

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